National Fenestration
Rating Council

National
Fenestration
Rating Council
Incorporated

NFRC 400-2001
Procedure for Determining
Fenestration Product Air Leakage

Foreword

Consumers today have a variety of energy-efficient fenestration products to choose from. One property, which may contribute to the energy impact of a fenestration product is its air leakage rate. The energy impacts of a given fenestration product from infiltrating air can be determined based on the air leakage rate, the differential air temperature and the differential humidity ratio.

This procedure has been developed by the National Fenestration Rating Council, Incorporated (NFRC) to meet the need for a uniform and accurate means for evaluating the air leakage rates of fenestration products. Air infiltration rates determined under this procedure are best used to assess the comparative performance of products. The air infiltration rates determined by this procedure are determined at a fixed set of environmental conditions and will need to be adjusted to directly determine seasonal energy performance.

Questions on the use of this procedure should be addressed to:

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1.0 Purpose

To specify a method for determining fenestration product air leakage.

2.0 Scope

2.1 This procedure defines the criteria for testing fenestration air leakage rates to the requirements and guidelines as established by the NFRC. Many of the criteria are referenced from other ASTM standards and NFRC 100. Issues of test pressures, leakage mode, test size, and test temperatures are based on currently acceptable and recognized industry practices for air leakage testing of window and door products.

2.2 This procedure is applicable to fixed and operable exterior windows, doors, and skylights.

2.3 Fenestration air leakage rates for a given product may vary depending on quality control, environmental factors (temperature, barometric, pressure, humidity, etc.), user-stresses, operating style differences, long term durability, variable installation methods, and material/design selection. This procedure does not address any of these issues. The air leakage rates obtained from this method are intended primarily for product comparison purposes.

3.0 Definitions

3.1 Product Line: A series of fenestration products specific to operator type (see Table 1 of NFRC 100) and framing material.

3.2 Individual Product: Any one specific fenestration product, specific to weatherseals, glazing method, hardware, assembly/fabrication methods, opening/non-opening configurations, ventilators, weep systems, and sills.

3.3 Projected Fenestration Product Area, (A_{pf}): The area of the rough opening in the wall, for the fenestration product, less installation clearance.

4.0 Test Criteria

ASTM E 283 [1] shall be the only method used to measure product air leakage rates [see note below 4.7]. The following conditions shall apply:

4.1 The differential static test pressure shall be 75 pascals (1.57 psf), applied to the exterior of the test specimen, so as to cause the air leakage to occur at the specimen's interior side.

4.2 The measured air leakage shall be corrected to standard atmospheric conditions of 101.3 kPa (760 Torr), 50 percent relative humidity, and 21.1C (70 F).

4.3 The rate of air leakage for all operable windows and doors shall also be reported as l/s•m^2 (cfm/ft^2).

4.4 The product test sizes shall be as defined in NFRC 100 or larger production size.

4.5 The leakage rate shall be measured to one decimal place in l/s•m^2 (i.e. #.#)

4.6 Operating force shall be measured and recorded per NAFS–1 for all fenestration products. The fenestration product shall be operated per ASTM E283 prior to an air leakage test being performed. No adjustments shall be made to the unit between conducting the operating force and air leakage tests.

4.7 Once the test specimen has been received by the laboratory, no material or component modifications to the product can be performed by the laboratory without written instructions from the manufacturer. The laboratory shall report all adjustments and modifications that were made to the product to obtain the reported air leakage rates.

Note: This procedure references the use of ASTM E283 as the only method for measuring individual product air leakage rates. ASTM E283 is a laboratory test method that has been used for many years to measure air leakage rates under controlled conditions. Because this test method measures air leakage rates at only one pressure differential, it is best used to compare the relative performance of fenestration products. It does not directly provide information on how a product will perform in a specific building application at field conditions.

NAFS-1 Operating Force Table

Product Type	Performance Class	Point of Force Application	Direction of Force	Maximum Force to Initiate Motion		Maximum Force to Maintain Motion	
				(N)	(lbs)	(N)	(lbs)
Vertically Sliding Hung Windows	R	Midpoint of operating handle(s) or of meeting rails	Vertical, parallel to plane of glazing	200	45	135	30
Vertically Sliding Hung Windows	LC	Midpoint of operating handle(s) or of meeting rails	Vertical, parallel to plane of glazing	230	50	155	35
Vertically Sliding Hung Windows	C, HC, & AW	Midpoint of operating handle(s) or of meeting rails	Vertical, parallel to plane of glazing	230	50	200	45
Vertically Sliding non-Hung Windows	R	Midpoint of operating handle(s) or of meeting rails	Vertical, Upward parallel to plane of glazing	230	50	155	35
Horizontally Sliding Windows	**R**	**Midpoint of operating handle(s) or of meeting stiles**	**Horizontal, parallel to plane of glazing**	**135**	**30**	**90**	**20**
Horizontally Sliding Windows	**LC, C, HC & AW**	**Midpoint of operating handle(s) or of meeting stiles**	**Horizontal, parallel to plane of glazing**	**180**	**40**	**115**	**25**
Horizontally Sliding Windows	**R, LC & C**	**Midpoint of operating handle(s) or of meeting stiles**	**Horizontal, parallel to plane of glazing**	**135**	**30**	**90**	**20**
Horizontally Sliding Windows	**HC & AW**	**Midpoint of operating handle(s) or of meeting stiles**	**Horizontal, parallel to plane of glazing**	**180**	**40**	**115**	**25**
Casement and Projecting Windows with rotary operators	**R, LC & C**	**End of crank handle**	**Perpendicular to crank handle and screw**	**70**	**15**	**30**	**7**
Casement and Projecting Windows with rotary operators	**HC & AW**	**End of crank handle**	**Perpendicular to crank handle and screw**	**90**	**20**	**45**	**10**
Casement and Projecting Windows with lever type operators	**R, LC & C**	**End of crank lever**	**Perpendicular to lever in the plane of its motion**	**155**	**35**	**100**	**22**
Casement and Projecting Windows with lever type operators	**HC & AW**	**End of crank lever**	**Perpendicular to lever in the plane of its motion**	**230**	**50**	**135**	**30**
Other Casement and Projecting Windows	**R, LC & C**	**Midpoint of sash opposite hinges or operating handles**	**Perpendicular to the plane of glazing**	**155**	**35**	**100**	**22**
Other Casement and Projecting Windows	**HC & AW**	**Midpoint of sash opposite hinges or operating handles**	**Perpendicular to the plane of glazing**	**230**	**50**	**135**	**30**
Roof Windows with Rotary Operators	**R, C, LC, HC & AW**	**End of crank handle**	**Perpendicular to crank handle and screw**	**90**	**20**	**45**	**10**
Other Roof Windows	**R, C, LC, HC & AW**	**Midpoint of sash opposite hinges or operating handles**	**Perpendicular to the plane of glazing**	**230**	**50**	**135**	**30**

5.0 Report

An NFRC 400 test laboratory report shall contain the following:

5.1 Information specified in ASTM E 283 in addition to that which is noted below.

5.2 All measured operating forces;

5.3 All air temperatures, atmospheric pressures, and humidities measured during the test;

5.4 All test differential pressures. All total air leakages, extraneous air leakages, and net specimen leakages measured in l/s (cfm) and corrected to standard atmospheric temperature and pressure conditions;

5.5 Total product air leakage rates measured in $l/s \cdot m^2$ (cfm/ft^2);

5.6 A complete description of the means of calibration of the airflow test apparatus and date of last calibration;

5.7 A description of any and all changes to the product, which were required in order to achieve the final air leakage rates. The laboratory shall provide the manufacturer's approval letter in this report; and

5.8 Report all product air leakage rates to one decimal place in accordance with ASTM E29, **with a minimum reported rate of 0.1.**

6.0 References

1. ASTM E 283-91 (1999), American Society for Testing and Materials Volume 4. 1999, "Standard Test Method For Determining The Rate Of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across The Specimen," ASTM, 1916 Race St., Philadelphia, PA. 19103. USA

2. AAMA/WDMA NAFS-1-2000 Voluntary Performance Specification for Windows, Skylights and Glass Doors

3. NFRC 100: Procedures for Determining Fenestration Product U-factors, National Fenestration Rating Council